

**Critical Decision 2b, Approve Performance Baseline
for the
Linac Coherent Light Source
at the Stanford Linear Accelerator Center**

**Office of Basic Energy Sciences
Office of Science**

A. Purpose

The purpose of this paper is to document the review by the Office of Science Energy Systems Acquisition Advisory Board-equivalent for Critical Decision 2b (CD-2b), “Approve Performance Baseline” for the Linac Coherent Light Source (LCLS) project at the Stanford Linear Accelerator Center (SLAC).

B. Mission Need

The mission of the Office of Science is “To advance basic research and the instruments of science that are the foundations for DOE’s applied missions, a base for U.S. technology innovation, and a source of remarkable insights into our physical and biological world and the nature of matter and energy.” The Linac Coherent Light Source (LCLS) project is a unique opportunity for a major advance in carrying out that mission.

The LCLS ranked third in near term priorities in SC’s *Facilities for the Future of Science – A Twenty Year Outlook*.

The LCLS will be the world’s first x-ray free electron laser (XFEL), serving as a research and development center for XFEL physics in the hard x-ray regime and as a facility for the application of XFEL radiation to experimental science.

The LCLS will be a source of coherent x-rays with unprecedented intensity and pulse duration. It is based on the SLAC linac, which can accelerate electrons or positrons to 50 billion electron Volts (GeV). The LCLS will utilize the last third of the SLAC linac accelerating electrons up to 14 GeV.

The LCLS will be the first XFEL in the world operating in the 1.5 - 15 Å wavelength range utilizing the first harmonic of the undulator (shorter wavelengths are possible using higher harmonics). The emitted coherent x-rays will have unprecedented brightness with 10^{12} - 10^{13} photons/pulse in a 0.2 - 0.4% energy band pass and an unprecedented time structure with a design pulse length of less than 230 femtoseconds. The unique characteristics of the LCLS will open new realms of scientific applications in the chemical, materials, and biological sciences.

C. Pre-requisites for Critical Decision 2b

1. Acquisition Execution Plan

The Acquisition Execution Plan was approved by the Under Secretary on October 16, 2002. The acquisition of the LCLS will be conducted through the existing Management and Operating contract with Stanford University. SLAC will execute those parts of the project

associated with conventional facilities and the acceleration and control of the electrons as well as overall system integration and management. The Advanced Photon Source Division at ANL will design and fabricate the undulator and associated systems. The Physics and Advanced Technologies Directorate at LLNL will design, fabricate, qualify, and commission the front-end x-ray optics.

Project activities will be accomplished to the extent feasible using fixed-priced subcontractors competitively selected by SLAC and the collaborating laboratories on the basis of best value, price and other factors. Additionally, subcontractors will be chosen based on their experience with similar jobs and their construction safety record. The acquisition strategy for the construction management contract of conventional facilities will be fixed-priced with incentives.

2. Project Execution Plan

The Preliminary Project Execution Plan (PPEP) was revised to reflect the LCLS performance baseline and is approved as part of the CD-2b process. The Project Execution Plan (PEP) defines the roles, responsibilities and authorities for project execution. The PEP is ready for approval by the SC Acquisition Executive.

3. External Independent Review

An External Independent Review (EIR) of the project was conducted by the Office of Engineering and Construction Management (OECM). OECM contracted with Burns and Roe Enterprises, Inc. to perform the review of the LCLS project in June 2004. The LCLS baseline Total Project Cost was \$315 million and project completion scheduled for September 2008. A final report was issued in August 2004. The project submitted a corrective action plan to address the recommendations of the EIR team. As of February 2005, over 70% (47 of 67) of the corrective actions are complete.

A limited EIR was conducted between January and March 2005 to evaluate the reasonableness of the revised cost and schedule baseline. The revised LCLS Total Project Cost is \$379 million and project completion is scheduled for March 2009. The baseline technical scope remained unchanged. The final EIR report concluded that the revised LCLS baseline was reasonable and OECM issued a project validation memo.

4. Project Management Control System

An Earned Value Management System (EVMS) was implemented for the LCLS project in March 2004. The system was reviewed by the External Independent Review team in June 2004 and concluded the system satisfies established requirements. OECM will schedule an on-site evaluation and certification review of the EVMS in 2005.

5. Preliminary Safety Assessment Document (PSAD)

A preliminary hazard analysis for the LCLS facility was conducted in June 2002. It identified potential hazards associated with the design, fabrication, construction, and testing phases of the project. The assessment of the hazards concluded that the LCLS is within the

existing safety and operating envelopes, the risks of all hazards will be similar in nature and magnitude to those already found in the present accelerator and synchrotron radiation programs, and the hazard impact will have only the potential for minor on-site and negligible off-site impacts to people or the environment.

The PSAD documents the assessment of actions to mitigate identified hazards. The PSAD process will continue to assess and develop mitigative action during Title II and will be approved prior to start of construction. The project will continue to evaluate hazards and develop controls for the operation and research activities during the development of the Final Safety Assessment Document.

6. Office of Science Independent Project Review

An Office of Science (SC) Independent Project Review (IPR) was conducted in August 2004. The purpose of the review was to evaluate the project baseline and long lead procurement readiness. The IPR Committee concluded that the project made considerable progress but the overall schedule was unrealistically aggressive. The Committee recommended further evaluation and adjustments to improve the schedule and cost contingency in project management, conventional facilities and injector system. The project was given an Action Item to re-evaluate the project's proposed cost and schedule baseline.

7. Revised Baseline Proposal SC-IPR

An Office of Science Mini-Review of LCLS was conducted on November 12, 2004. The purpose of the review was to assess the changes between the baseline presented to the August 2004 IPR and the revised cost and schedule baseline proposal. The Committee found the proposed baseline to be reasonable and it appropriately accounted for the impact of the FY 2005 Continuing Resolution; the project had adequately responded to the August IPR recommendations; and the project could be managed successfully to completion with the implementation of the changes to the project management organization. BES fully supports the revised cost and schedule baseline proposal as reflected in Section E of this document.

D. Project Scope Baseline

The scope baseline of the LCLS project consists of a 135 MeV injector to be built at Sector 20 of the 30-sector SLAC linac to create the electron beam required for the XFEL. Portions of the last one-third of the linac will be modified by adding two magnetic bunch compressors. Most of the linac and its infrastructure will remain unchanged. The existing components in the Final Focus Test Beam tunnel will be removed and will be replaced with a Beam Transfer Hall (BTH). An Undulator Hall (UH) tunnel and associated equipment will be installed after the BTH. Two new below grade experimental halls will be constructed. The Near Hall and the Far Hall will be built approximately 70 meters and 400 meters downstream of the UH, respectively. The Near Hall and the Far Hall will be connected by an x-ray transport tunnel. A Central Laboratory and Office building will be constructed at the Near Hall site.

E. Project Cost and Schedule Baseline

The baseline budget authority (BA) funding requirements for the LCLS project were established in the FY2006 Congressional Project Data Sheet and are shown below. The Total Estimated Cost (TEC) baseline is \$315.0 million. Other Project Costs (OPC) total \$64.0 million. The Total Project Cost (TPC) baseline is \$379.0 million. The cost and schedule baseline is based on receiving the following BA funding profile.

Linac Coherent Light Source BA Funding Profile (\$K)									
	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	Total
TEC	0	5,925	7,456	49,674 ¹	85,544	105,901	50,500	10,000	315,000
OPC	1,500	0	2,000	4,000	3,500	16,000	15,500	21,500	64,000
TPC	1,500	5,925	9,456	53,674	89,044	121,901	66,000	31,500	379,000

¹ FY2005 TEC funding includes \$29,760,000 for long lead procurements.

The schedule baseline is as follows:

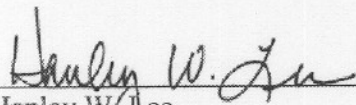
CD-0	Approve Mission Need	June 2001 (A)
CD-1	Approve Preliminary Baseline Range	October 2002 (A)
CD-2a	Approve Long-Lead Procurement Budget	July 2003 (A)
CD-2b	Approve Performance Baseline	April 2005 (A)
CD-3a	Approve Start of Long-Lead Procurements	December 2004 (A)
CD-3b	Approve Start of Construction	February 2006
CD-4	Approve Start of Operations	March 2009

Note: (A) indicates actual milestone completion date.

F. Environmental Strategy

The LCLS will be designed, constructed and operated in compliance with all requirements of the National Environmental Policy Act (NEPA) and its implementing regulations. Design, construction and operation activities have been evaluated in the NEPA Environmental Assessment (EA1426) for the LCLS Project. A Finding of No Significant Impact was issued on February 28, 2003.

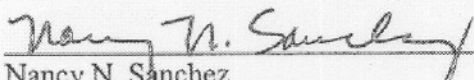
Submitted by:



Hanley W. Lee
Federal Project Director
Stanford Site Office

4-5-05

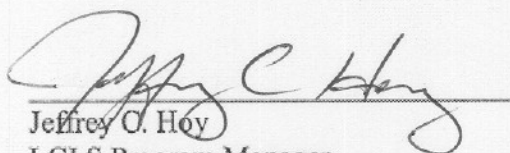
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Nancy N. Sanchez
Site Manager
Stanford Site Office

4-6-05

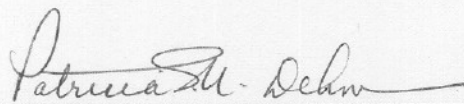
Date



Jeffrey C. Hoy
LCLS Program Manager
Office of Basic Energy Sciences
Office of Science

4/8/05

Date



Patricia M. Dehmer
Director
Office of Basic Energy Sciences
Office of Science

4/8/2005

Date

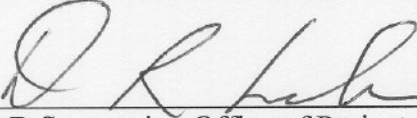
Approve Performance Baseline (CD-2 2b) Sample Document

Linac Coherent Light Source

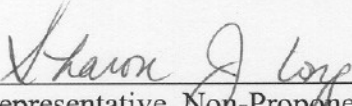
Critical Decision-2b

Recommendations

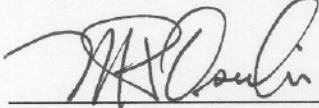
The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) approval of CD-2b, *Approve Performance Baseline*, for the Linac Coherent Light Source at SLAC as noted below.

 4/8/05


ESAAB Secretariat, Office of Project Assessment Date Yes ☒ No ☐

 4/8/05

Representative, Non-Proponent SC Program Office Date Yes ☒ No ☐

 4/8/05

Representative, Financial Management Division Date Yes ☒ No ☐

 4-8-05

Representative, Environment, Safety and Health Division Date Yes ☒ No ☐

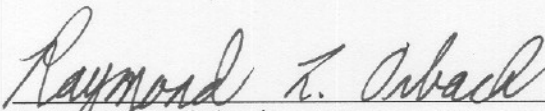
Representative, Security Management Team Date Yes ☐ No ☐

Representative, Laboratory Infrastructure Division Date Yes ☐ No ☐

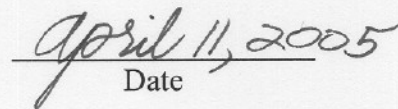
Representative, Grants and Contracts Division Date Yes ☐ No ☐

Approval

Based on the material presented above and at this review, Critical Decision-2b, Performance Baseline is approved. Therefore, full construction funding (beyond long-lead procurement) for the Linac Coherent Light Source project may be included in the Department's FY 2006 budget request.



Raymond L. Orbach
Director
Office of Science


Date